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ABSTRACT

This autoinstructional program deals with the study of the pH of given substances by using litmus and hydrion papers. It is a learning activity directed toward low achievers involved in the study of biology at the secondary school level. The time suggested for the unit is 25-30 minutes (plus additional time for further pH testing). The equipment needed is itemized. With the student script there is included a pH worksheet that can be used for recording the observations made and answering suggested questions relevant to observations made. (EB)

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pH

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TEACHER'S GUIDE

PACKET NUMBER	546.24 H
SUBJECT	Biology
TITLE	pH
LEVEL	Low - High School
GRADE	10
BEHAVIORAL OBJECTIVES	To record pH of given substances by using litmus and hydrion papers To record if a given pH is acid or base To record how much stronger one acid is than another or one base is than another
TIME	25 - 30 minutes (plus additional time for further pH testing)
EQUIPMENT	tape recorder cassette tape chart test tube A - acid test tube B - base test tube C - base (not same as B) test tube D - acid (not same as A) unknowns (H_2O samples) Envelope A - blue litmus Envelope B - red litmus Envelope C - hydrion papers Worksheet

SCRIPT

BIOLOGY
pH

Hi! Do you know what is meant by pH? It is always written with a small p and a capital H. pH is a measure of acidity. In this AT you will learn about the pH scale and acid-base relationships. Look at CHART I before you. This chart of numbers represents the pH scale that tells us just how acidic or how basic something is. Let us start with something neutral - water. Water is neither acid nor base and is given the pH of 7. Seven on the pH scale means neutral. Do you know the difference between an acid and a base? To find out let's look at the water molecule shown on CHART II. You have probably heard water referred to as H_2O. This means that the water molecule has two hydrogen atoms represented by the letter H and one oxygen atom represented by the letter O. In this form water is neutral - neither acid nor base and therefore has the pH of 7 on the scale. On CHART II the water molecule is written in three different ways. First of all it is written as H_2O. This shows how many atoms of each element are in one water molecule. Secondly it is written showing the two pH's for hydrogen bonded onto the O for oxygen. The third diagram shows what happens if the water molecule is split into a single hydrogen and an oxygen hydrogen pair. The hydrogen resulting from this split gives acid qualities to a substance. The oxygen hydrogen pair called a hydroxide resulting from this split gives the qualities of a base

to a substance. In other words all acids contain hydrogen ions and all bases contain hydroxides. Let's see what that means.

Take two pieces of paper from ENVELOPE A and touch the tip of one to the liquid in TEST TUBE A and the other to the liquid in TEST TUBE B. Record the results on the answer sheet and turn the tape back on when you have finished.

MUSIC

You should have found that the paper turned pink in TEST TUBE A but that there was no color change in TEST TUBE B.

Now take two pieces of paper strips from ENVELOPE B and touch the tip of one to the liquid in TEST TUBE A and the other to the liquid in TEST TUBE B. Record these results.

MUSIC

You should have found this time that the paper turned blue in TEST TUBE B but that there was no color change in TEST TUBE A.

You may not realize it but you have just tested two substances to see if they are acid or base. The papers you used are called litmus paper. Acid turns blue litmus paper pink so TEST TUBE A is acid. Bases turn red litmus paper blue, so TEST TUBE B is a base. Now remove two more litmus papers from each envelope and check TEST TUBE C AND D to see if they are acid or base. Record your results on

the worksheet. Remember that if a blue paper turns red, it's acid - if red turns blue, it's base. Turn the tape back on when you're done.

MUSIC

You should have gotten the following results: The substance in C should have had no effect on the blue paper, but should have turned the red paper blue. Therefore, it is a base. The substance in D should have had no effect on the red paper but should have turned the blue paper pink. Therefore, it is an acid.

You are probably wondering now why the acids and bases turn colors. The papers contain chemicals that are very sensitive to certain things. The blue paper's chemical is sensitive to the presence of hydrogen ions. Since all acids contain hydrogen ions they cause the color change in blue litmus paper. The red paper is sensitive to the presence of the OH ion called hydroxide. Since all bases contain hydroxide, they cause the change in the blue paper.

Now take four pieces of paper from ENVELOPE C. Touch one piece to each of the TEST TUBES A, B, C, AND D. Mark each carefully so that you won't confuse them. Turn on the tape when you have finished recording the color changes on the worksheet.

MUSIC

We have already determined that the substances in TEST TUBES A AND D were both acids. Did they both give the same results? You should

have gotten two different colors. Can you think of any reason why two acids would react differently with the same kind of paper? The answer is simple. They are of different strengths. The same thing is true of the two bases, B and C. They are both bases but reacted to form two different colors. They are therefore of different strengths.

In front of the room your teacher has posted the chart for reading these papers called hydrion papers. Take each of the four papers from A, B, C, and D and record the number of the color change indicated. If the color of your paper is between two shades, give it a decimal estimate. For example, if you found it to be half way between numbers 4 and 5, call it 4.5. List the results on your worksheet. Compare your results with your teacher's. Turn the tape back on when you have finished.

MUSIC

Hopefully, the numbers you read were the same as or close to those of your teacher. If not take four more papers and try again. Did you find that the two acids found in TEST TUBES A AND D had numbers less than 7 and that the two bases in B and C had numbers greater than 7? Look at CHART I again. Now that you are more familiar with pH, let's see what the scale means.

The numbers on the pH scale represent how acidic or how basic a substance is. Remember at the beginning of the tape I said that

BIOLOGY
pH

pure water is neutral and has a reading of 7. If something reads lower than 7, it is an acid. The lower the number, the stronger the acid. If something reads higher than 7, it is a base. The higher the number, the farther it is from neutral so the stronger the base. Using this information and the chart, answer section 6 on the worksheet. Turn the tape on when you are done.

MUSIC

See if your answers agree with mine.

a reading of one is acid

a reading of 6 is acid

a reading of 12 is base

a reading of 3 is acid

a reading of 7 is neutral

a reading of 8.6 is base

As we said, water is neutral in its pure form.

In question 6 - an acid reading 1 is stronger than one reading 3. A base reading 10 is stronger than one reading B. Remember that the further you get from 7, the stronger the substance is. Therefore, for acid a lower number is stronger, but for a base, the higher number is stronger.

There is one last thing to be said about the numbers on the scale. They not only indicate if one substance is stronger than another

but they tell how much stronger they are. As you move from number to number the value jumps by 10. Look at the scale again. If you had two acids, one reading 6 and the other 5, which would be stronger? The answer is five because it is lower and farther from neutral 7. If you answered this right, you're beginning to get the knack of pH. Since each number represents a jump of ten times, an acid reading 5 is ten times stronger than one reading 6. That means it has ten times as many hydrogen ions. Which is stronger, an acid reading 3 or 2? The answer is 2 and it is ten times stronger. Which is stronger, a base reading 12 or 11? The answer is 12 because it is farther from neutral 7. It is ten times as strong since each number represents an increase in strength of ten times. Now, how much stronger is a base reading 11 than one reading 9? The answer is 100 times since each number means an increase of ten and since there is a jump of 2 numbers, the strength is 10 times 10 or one hundred. Are you beginning to catch on?

Now you may ask; What does all this chemistry have to do with the biology we've been studying? It's very important. All living things live best at a certain pH. One plant may live in a slightly acid soil while another thrives in a base. A farmer has to know what pH is best for his crops and what to add to his soil if the pH has to be improved. On a television ad you hear about acid

stomachs and that to relieve them you should take Alka Seltzer. If your stomach becomes too acidic your body protests in one way or another. Alka Seltzer is a base. By taking it you are cutting down on the acidity and bringing things back to normal.

A diabetic will go into coma if his blood pH changes drastically. This affects his whole body since the blood passes everything in its travels.

As far as the study of ecology is concerned, knowing about pH is very important. If a pollutant is added it may change the pH. This causes desired things to die and undesired things to thrive. Your teacher has several things to be tested for pH. Test them with the papers and determine the pH. Record this on your answer sheet in the chart for #7. Your teacher may ask you to interpret your readings so concentrate on what the various pH readings might mean. When you're done, rewind the tape and leave things as you found them.

MUSIC

pH WORKSHEET

1. What did you observe when:

   a. the blue paper was touched to liquid A?

   b. the blue paper was touched to liquid B?

   c. the pink paper was touched to liquid A?

   d. the pink paper was touched to liquid B?

2. Is substance C acid or base?
   How do you know?

3. Is substance D acid or base?
   How do you know?

4. What did you observe when you touched the paper from envelope C to:

   a. test tube A

   b. test tube B

   c. test tube C

   d. test tube D

5. What numbers did you record for the following with the hydrion paper?

   a. test tube A

   b. test tube B

   c. test tube C

   d. test tube D

6. Given the following readings, record if the following are acid or base.

(a)

a reading of 1

a reading of 6

a reading of 2

a reading of 3

pH WORKSHEET

a reading of 7

a reading of 8.6

6. Underline which is stronger of each of the following pairs/
(b)

an acid reading of 1 or 3?

a base reading 8 or 10?

7.

SUBSTANCE	COLOR CHANGE	pH